

# Recent Studies on Peach Yellows and Little Peach



PEACH TREE IN ADVANCED STAGE OF YELLOWS

NEW JERSEY  
AGRICULTURAL EXPERIMENT STATIONS

NEW BRUNSWICK, N. J.

October, 1921

# NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS\*

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BULLETIN 356

October 1, 1921

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## Recent Studies on Peach Yellows and Little Peach

M. A. BLAKE, MEL. T. COOK AND C. H. CONNORS

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### Introduction

"Peach yellows" and "little peach" are peculiar American diseases of the peach which have been responsible for heavy losses in many localities in this and some other states. They are also said to occur on nectarines, almonds and apricots and the same or very similar diseases attack the plum. The term "yellows" is also applied to many other plants when showing certain peculiar symptoms, more or less similar to the symptoms of peach yellows, but we have no data enabling us to determine whether they are the same or different. The diseases are also supposed to be of the same general character as the "mosaic" or "calico" diseases of tobacco, the mosaic of tomato and pepper, the mosaic and "leaf roll" of potato and similar troubles on other plants.

The term "peach yellows" came into use early in the nineteenth century and was used to describe a disease of the peach, which had its origin in the lower part of the Delaware River valley some time during the latter part of the eighteenth century. The importance of the disease was very soon recognized and many methods have been suggested and tried from time to time in order to eradicate or control it. Symptoms similar to those characteristic of yellows may develop as a result of other causes. Therefore, we have reason to believe that many of the early records are incorrect and that many efforts for the eradication or control of the disease have been unknowingly directed at troubles due to other causes.



In this connection, it is interesting to know that a prize of \$60.00 offered in 1798 for a method of preventing "yellows" was divided between two contestants, both of whom attributed the disease to in-



FIG. 1.—TREE IN LAST STAGES OF YELLOWS. ALL TWIGS ARE DEAD EXCEPT THE TYPICAL YELLOWS SHOOTS

sects. The first record of "yellows" that is in any way authentic was in 1791, but there is very little doubt that some of the records previous to that date are for true "yellows."

In 1806-07, the disease was restricted to an area in the immediate vicinity of Philadelphia, extending into Pennsylvania, New Jersey and Delaware. Within a few years it had extended into New York and Maryland and gradually spread north, south and west. It is

thought to have reached Connecticut about 1815, but was not reported from Canada until about 1870.

"Little peach" was first discovered in Michigan in 1893, and was reported at Marlton, N. J., in 1905 and 1906. It was identified in two trees at Vineland in 1907. It is now more or less generally distributed throughout the state.



FIG. 2—TYPICAL YELLOWS SHOOT UPON A YOUNG TREE THE SECOND SEASON IN THE ORCHARD

### Distribution

Peach yellows appears to be confined to a more or less definite section of the United States and the peach district of Ontario, Canada. The region in the United States extends south from Massachusetts to South Carolina along the Atlantic coast and west to Michigan, Illinois, Missouri and Kansas. The southern boundary crosses northern Oklahoma and Arkansas, includes most of Tennessee and





FIG. 3—TYPICAL YELLOWS SHOOT WITH ONE NORMAL HEALTHY LEAF  
AT RIGHT



the northern corner of South Carolina. An isolated area in southern Nevada has been reported. Yellows has never appeared in California and the state has a quarantine against the introduction of trees, pits, or fruit from sections where the disease prevails.

Little peach is apparently not quite as widely distributed as yellows at present, but occurs from New England as far south as Virginia and west to Michigan, and in some of the other western states in which yellows prevails.

Peach rosette is confined to certain southern peach regions. It was first reported from Georgia in 1879. Since that time it has been found as far west as Kansas and as far north as South Carolina.

TABLE 1

*Results of Examinations at South Haven, Mich.  
By D. B. Williams, Yellows Commissioner*

Year	Number of Trees examined	Number with Yellows	Per Cent Diseased
1879 .....	62,856	2,245	3.5
1880 .....	68,758	5,675	8.0
1881 .....	71,353	3,256	4.5
1882 .....	120,425	4,544	4.0

### Losses

Many estimates of the losses due to peach yellows have been made, but some of the figures are likely to be unreliable. There is no doubt that in many supposed cases of yellows, the symptoms were due to other causes and the losses were overestimated; but after making due allowance for over estimates we must recognize that the losses have been very large.

One of the earliest and apparently authentic estimates covers four years of inspection of orchards from about 1879-82 at South Haven, Mich., by Williams, and reported by Smith,<sup>1</sup> as shown in table 1.

Yellows is supposed to have appeared in Michigan about 1866 or 1867, but did not become prevalent enough to attract much notice until about 1870. The period covered by the figures is evidently what might be called a quiescent one, for a few years later Smith writes, "The peach industry was literally swept out of Berrien County by yellows within one decade."

<sup>1</sup>E. F. Smith, 1888, Peach Yellows, U. S. Dept. Agr., Div. Bot., Bul. 9.

In 1888 Smith<sup>1</sup> also showed by diagram the results of studies of yellows in several orchards in Delaware at the time of an outbreak.

In the orchard of Joseph McDaniels at Dover, Delaware, set in



FIG. 4.—AN ELBERTA TREE IN FULL BEARING WITH ONE CENTRAL BRANCH AFFECTED WITH YELLOWS. NOTE THE THIN AND ROLLED APPEARANCE OF THE FOLIAGE ON THIS BRANCH

1884, he reports 887 trees out of a total of 1,777, or about 50 per cent, affected with yellows in 1887. In another orchard belonging to J. Frank Denney, out of a total of 2,146 trees set in 1881 only 130 were found to be healthy in 1887. Some orchards showed much smaller losses but these illustrate the seriousness of the disease.



In a yellows and little peach district a loss of 1 per cent of the trees annually is low even during what might be called a quiescent period between epidemics, while a loss of from 2 to 3 per cent by infection per year is common. During so-called epidemics the percentages may increase to 25 per cent even in orchards where the diseased trees are removed annually, as was the case at Vineland, reported later on pages 46 to 53.

The United States Census for 1910 reports 15,508,921 bearing and non-bearing trees for New York, New Jersey, Pennsylvania, Delaware and Maryland. An ordinary loss of 3 per cent for this territory would amount to 450,000 trees annually. The same report places the number of bearing and non-bearing trees for New Jersey at 2,580,108. A 3 per cent loss would mean 75,000 trees per year in this state alone.

A survey by the department of horticulture of the New Jersey Agricultural Experiment Station in 1913 showed a total of more than 109,000 peach trees within a radius of 5 miles of Vineland, N. J. The losses in the experimental orchards exceeded 20 per cent in 1920. One can thus judge the extent of damage which these peach diseases may cause in a local peach center.

### **New Jersey Investigations**

An extensive study of the problems connected with commercial peach production in New Jersey was begun by the State Experiment Station in 1905 in an effort to assist in the revival of the industry following the ravages caused by the San Jose scale.

Experimental orchards were planted at High Bridge and Vineland, N. J., in 1906, 1907, 1908 and 1912. The principal features of these experiments as first planned were the fertilizer treatments, and it was early decided to keep a complete record of the yield of each tree under test. This led to close observations of many hundred individual trees of various varieties from several sources, and under many treatments.

A few trees in these orchards failed to grow as well as others and developed advanced and unmistakable symptoms of yellows and little peach within three years of the time of planting. Therefore, it was deemed wise to keep an accurate account and record of the individual trees which became diseased from year to year. This was done in the case of each orchard. The results are shown in the colored diagrams following page 32.

The early appearance of the disease on some trees in these young orchards led us to suspect that they were affected with yellows in the nursery. A complaint also from a Burlington County peach grower as to the behavior of his young peach trees was followed by an investigation by the horticulturist and advanced symptoms of yellows were found developing in an orchard within 4 months after planting. Further investigations indicated that these trees must have been diseased before leaving the nursery. Since that time many other cases of yellows and little peach have been observed in trees soon after



FIG. 5—HEALTHY FRUIT AT LEFT. PREMATURE RED-SPOTTED FRUIT AT RIGHT

planting, and in nursery stock, some of which were less than one year old from time of budding. The disease was also found to be much more prevalent in certain blocks of trees in orchards than in other blocks of the same varieties and ages. Further investigations usually brought out the fact that these blocks of good and poor trees were from different sources. It was also learned that both nursery-men and orchardists occasionally selected bud wood from trees which were apparently vigorous and healthy, but which in reality were slightly diseased. This was to be expected since very little was known about early or preliminary symptoms. One grower budded three hundred seedlings from a supposedly early variety of Elberta which later died with yellows. All of these trees developed yellows the first year of bearing.



The authors are led to believe that some nurserymen and many budders employed by nurserymen are unable to recognize the early symptoms of the disease. All who are responsible for the propagation and growing of peach stock should be familiar with the early as well as the advanced symptoms of these diseases.

Workers who have made a study of peach yellows and little peach fully appreciate that in order to make a positive diagnosis of these diseases in trees before they come into bearing necessitates a close study of the subject. Observations at the New Jersey station have led to the determination of certain early symptoms that indicate the probable presence of these diseases before the well defined or advanced symptoms appear. The results of this work were published in Bulletin 226 of the Agricultural Experiment Station in January, 1912. Previous to 1912, all of this work was under the supervision of the senior author, but beginning with 1912, the work has been carried on cooperatively by members of the departments of horticulture and plant pathology.

### **Symptoms of Advanced Stages of Yellows**

Before entering into a discussion of the investigations with these diseases it may be well to note the symptoms attributed to them. The following symptoms have been commonly regarded as indicating that a tree is unquestionably affected with yellows.

#### **Premature Fruit**

The fruit on diseased trees may ripen from a few days to three weeks in advance of the normal time of ripening of the variety. Such fruit is commonly more or less red spotted and blotched with color, rather than normally blushed, marked and washed with red as shown in figure 5. These spots and blotches of color may occur largely in the skin of the fruit or through the flesh to the pit. The flesh also is more prominently marked with red around the pit than is the case with normal fruit. The flavor of the diseased fruit may vary from nearly normal to insipid or bitter. The fruit may be larger or smaller than on normal trees, depending upon the conditions which will be described later. The premature fruit is very susceptible to attacks of brown rot, probably because the skin of such premature fruit is less resistant than that of normal fruit.

### **Wiry, Branched Shoots**

The development of sickly, wiry and finely branched shoots on the trunk and branches is a symptom of yellows regarded in identifying the disease as of equal importance with the premature fruit. These shoots have very narrow leaves and frequently continue to grow late in the season after the rest of the tree has stopped. Sometimes prematuring of the fruit occurs alone and for several seasons before the appearance of the sickly, wiry shoots. In other cases, the abnormal shoots may appear on young trees before fruiting age and also on bearing trees even before prematuring is apparent. These characteristic shoots branch profusely and become so finely divided that they may often be detected on the trees in winter.

### **Yellow Appearance of Foliage**

Another symptom attributed to yellows is the yellowish green appearance of the foliage on affected trees. This symptom may be very misleading, as many other factors may cause such an appearance. It is also true that diseased trees may have a rich green color, especially if given a good supply of nitrogen. It was quite commonly believed that yellows trees were short-lived and would die within a few years after the appearance of prominent symptoms. While it is true that these trees will be weakened and may die within a few years after the appearance of the disease, it is also true that many diseased trees may remain alive and persist as long as many normal trees under usual conditions of growth.

### **Symptoms of Advanced Stages of Little Peach**

This disease differs from yellows in that instead of prematuring, the fruit remains small and ripens from a few days to ten days later than normal fruit of the same variety. The diseased fruits are often flattened and somewhat rectangular in form, instead of being well rounded (fig. 6). Combined with the late ripening is the characteristic drooping of the foliage toward the branches and trunk, and the curling and rolling of the leaves. The color of the foliage also becomes a lighter and usually a mottled yellow green. Many of the leaves also lose their flexibility to a considerable degree. If the tree is vigorous and growing rapidly, the leaves at the tips of the branches may appear normal.



### Early Preliminary Symptoms of Yellows and Little Peach

In recent years, other symptoms have been noted as of value in determining whether trees are affected with either yellows or little peach. These symptoms are of special importance in detecting the



FIG 6—NORMAL AND LITTLE PEACH SPECIMENS OF GREENSBORO

disease in young trees but they do not necessarily distinguish one from the other. A preliminary report upon these symptoms was published in Bulletin 226, of the New Jersey Agricultural Experiment Station. The most constant and reliable symptoms of an early stage of yellows consists of a characteristic drooping of the leaves toward the branches and trunk of the tree, combined with a slight rolling or curling of the tips toward the petioles and sometimes a rolling inward of the margins as well. Such leaves lose their flexibility and

are frequently smaller than normal leaves. They vary from light green in color to a yellowish mottled green. Such leaves often show a lighter and yellower green than normal leaves and a reddish margin. This appearance of the foliage is quite distinct from the dropping and flaccid condition of leaves upon trees suffering from drought. Young



FIG. 7—YELLOWS SHOOT UPON CUT BACK TREE HOLDING FOLIAGE IN EARLY WINTER. PEACH TREE IN ADVANCED STAGE OF YELLOWS

trees affected with this disease are usually somewhat checked in growth and assume a more upright and less spreading habit than normal trees.

#### Rolling of the Leaves

In some instances the first indication of yellows is a rolling of the foliage from the margin inward, giving the leaves a rounded or pencil shape; the lenticels of the bark also are much enlarged. These may be the only symptoms on young trees and the first symptoms on older trees. These symptoms are brought about also by any factor which interferes with the circulation of the sap in the tree, such as girdling in any form, winter injury at the collar, borer injury and damage by



label wires. The appearance of such a case in an orchard calls for a detailed examination before making a decision as to the exact cause. (See figures 15, 16, 17, and 18).

#### Early Blooming and Bud Growth

Vigorous trees affected by yellows and little peach invariably start to make spring bud growth and bloom in advance of normal trees of



FIG. 8—TWIGS FROM NORMAL ELBERTA AT LEFT AND FROM YELLOWS ELBERTA AT RIGHT. CUT FROM TREE EARLY IN SPRING

the same variety. Girdling, insect, winter and other injuries may cause a similar behavior of the tree and should not be confused with yellows.

#### Yellows and Little Peach on Same Tree

A number of trees at Vineland were observed at different times that appeared to be affected by both yellows and little peach but there was always some degree of uncertainty. During 1917, however, a Hiley tree at Vineland developed clear cases of both yellows and little peach on different branches. The fruit was premature on some, while at the same time there were branches with normal fruits and

several which produced typical little-peach fruits throughout their entire lengths. Buds were cut from the yellows and little peach parts of the trees and propagated in the nursery. Several trees from each source were secured and planted out in orchard form in 1920. It is too early to determine whether the diseases will propagate distinct from each other from this tree.

### **Factors Producing Symptoms Similar to Yellows and Little Peach**

Symptoms practically identical with those characteristic of yellows are frequently due to other causes. This fact throws more or less doubt on all the early records and on many of the later reports of the occurrence of yellows, and no doubt accounts for the supposed recovery of trees said to have been affected with yellows. The most common causes of these symptoms are:

- (a) Girdling by borers or mice.
- (b) Injuries due to climatic factors.
- (c) Mechanical injuries, including label wires.
- (d) Improper fertilization with plant-foods.
- (e) Lack of or improper cultivation.
- (f) Other plant diseases.
- (g) Unfavorable soils.

It is very probable that many of the reports and records of the occurrence of peach yellows are the results of incorrect diagnosis and that the symptoms were due to some of the causes indicated above. No doubt many trees supposedly affected with yellows have been destroyed.

### **Peach "Buttons"**

In seasons following cold or severe weather many varieties of peaches may produce a number of small fruits or "buttons" which cling to the tree throughout the season but fail to develop to a size much larger than a hickory nut. The J. H. Hale variety does this quite frequently, but whether because of winter injury alone or because of faulty pollination, or both, is uncertain. Palmer suggests that these "buttons" are due to improper pollination. He believes that pollen of St. John and other varieties, including J. H. Hale, is impotent to a considerable degree varying with the season. Connors<sup>2</sup> has noted at the New Jersey Agricultural Experiment Station that the anthers of J. H. Hale and some of the seedlings in the breeding experiment are in such condition as to suggest the possibility of partial or complete impotency of the pollen; but whether this is normal to

<sup>2</sup>Unpublished data.

the variety or is an indirect result of weather injury is yet to be determined.



FIG. 9—TWIGS FROM TREES AFFECTED WITH ROSETTE. (Photograph secured in Georgia by M. A. Blake.)

### **Peach Rosette**

This disease is apparently similar in nature to yellow and little peach but confined to the more southerly section. It is similar to and may be a southern form of the same malady. Trees affected with the disease commonly die within a few months after the symptoms develop and have not been known to live longer than 3 years. The disease is easily recognized by the bunching of the foliage into rosettes. It does not occur in New Jersey and will not receive further attention in this bulletin.



### **Behavior of Trees on Wet Soils**

Peaches are occasionally planted on low wet areas, although all authorities state that this should not be done, and that the peach requires well-drained soil. There are often limited areas in an otherwise well-drained field that are too wet at times for the best results with peaches. We therefore find a proportion of peach trees growing under such unfavorable conditions. They may assume an appearance almost identical with certain stages of yellows. The foliage of such trees may become distinctly yellow in color, relatively small in size and the tip growth may show a rather narrow foliage similar to yellows. Trees of this kind are frequently condemned by persons who suppose them to be affected with yellows.

### **Peculiar Behavior of Trees on Some Well-Drained Soils**

Trees on well-drained soils may sometimes assume much the same appearance as described for wet soils when some factor destroys many of the small rootlets and root hairs. The roots of trees exhibiting these symptoms have been examined in a number of instances and on all of them dead rootlets and root hairs were noted. It requires close observation and some experience to distinguish between trees affected in this way and true cases of yellows. Such trees are readily distinguished from yellows and little peach by the fact that the starch accumulated in the leaves during the day is transferred normally during the night while in the case of trees diseased with yellows and little peach the transfer is reduced or inhibited. Figures 10 and 11 illustrate a normal and an affected tree in an orchard near Sewell, N. J., in 1920. Three such affected trees from this orchard were transferred to other soil at New Brunswick by a graduate student, Mr. David Schmidt, in the spring of 1921. They have already begun to recover from the unfavorable soil conditions which inhibited their growth at Sewell, N. J.



FIG. 10—TREES IN ORCHARD NEAR SEWELL, NEW JERSEY, AFFECTED BY UNKNOWN SOIL TROUBLE. SYMPTOMS LIKELY TO BE MISTAKEN FOR YELLOWS



FIG. 11—HEALTHY TREE IN SAME ORCHARD AS TREE SHOWN IN FIGURE 10.

### **Trees More Susceptible to Disease on Some Sites than on Others**

It has been observed at the New Jersey station that a lot of trees of a single variety may be secured from a nursery, divided and set on two different pieces of land, and the two behave much differently as to percentages which become diseased. One lot may suffer considerable losses from yellows and little peach within four or five



FIG. 12—TREE IN FOLIAGE SHOWING EFFECT OF LITTLE PEACH

years while the other may be only slightly affected. This occurred in the case of a lot of trees which were secured for planting in the experiment orchard at Vineland in 1908. Those planted in the experiment orchard suffered slight loss from yellows and little peach, while some trees from the same lot set in orchard form in a garden about  $\frac{1}{4}$  mile distant all became diseased by the fifth or sixth year. This comparison covered trees of more than five varieties and from two nurseries. Again in 1912 trees of the varieties Stump, Carman and Elberta were purchased from one nursery for pruning experiments at Vineland and New Brunswick. The trees were secured



from the same nursery and planted the same year. The total losses at Vineland amounted to 3.33 per cent by the end of the fifth summer, while those at New Brunswick were 23.61 per cent. The figures at the close of the sixth summer were 11.66 per cent for the Vineland and 36.11 per cent for the New Brunswick trees. The total loss was three times as great at the latter place. There are apparently conditions under which trees readily become diseased while at other points they do not, although no farther distant than  $\frac{1}{4}$  mile.



FIG. 13—MOUNTAIN ROSE TREE AFFECTED WITH LITTLE PEACH AT TIME OF PLANTING IN THE ORCHARD. GROWTH COMPACT AND UPRIGHT

### **Fertilizers Had No Apparent Effect in Checking the Spread of These Diseases at Vineland**

Smith<sup>3</sup> showed rather conclusively, as early as 1888, that applications of plant-food or fertilizers had no effect in checking the spread

<sup>3</sup>Smith, E. F., 1893. Experiments with Fertilizers for the Prevention and Cure of Peach Yellows, 1889-92. U. S. Dept. Agr., Div. Veg. Path., Bul. 4.

of or curing yellows. The question, however, is brought forward frequently, and further evidence is furnished by the Vineland orchards on both yellows and little peach.

The fertilizer treatments varied from the check, or no-fertilizer treatments, to an annual application per acre of 10 tons of stable manure plus 100 pounds of ground bone, 200 pounds of acid phosphate and 150 pounds of high-grade sulfate or muriate of potash. One plot received nitrate of soda at the rate of 250 pounds per acre in addition to phosphoric acid and potash in amounts equal to those mentioned above. At times, non-fertilized or lightly fertilized trees would appear more susceptible to yellows and little peach than trees receiving liberal amounts of plant-food. In other cases the reverse would appear to be true. These observations over a period of 14 seasons agree with those of Smith. It should be noted, however, that good culture and liberal applications of plant-food may keep diseased trees more vigorous and delay general breakdown and death.

### **Factors Which Determine Size and Time of Maturity of the Fruit on Normal Trees**

The symptoms of yellows and little peach are so similar to those produced by other factors interfering with the growth of the peach tree that an understanding of the normal plant-food metabolism in the tree and the influence of the common factors of its environment are necessary before one can clearly understand an extended discussion of yellows and little peach.

In order to produce desirable fruit, a tree must be able to maintain a certain amount of growth and vigor. To this end, both plant-food and moisture are essential. Given favorable conditions for growth, the development of the tree depends upon the taking up of crude plant-food by the roots, photosynthesis in the leaves, and translocation of the elaborated foods. In a normal tree, the elaborated plant-food to a large degree is stored up as starch in the leaves and young stems during the day; is converted into sugar at night, and is then available for the support of growth and development in various parts of the tree or for storage for future use. When the tree is young this food is used for growth but when the tree reaches the bearing stage, it is used for both growth and fruit production.

It has been observed that rapidly growing peach trees may set a few fruits as early as the beginning of the second sea-

son's growth, but these fruits fall from the trees in June even though apparently perfectly pollinated and free from serious insect or disease attacks. The rapid vegetative growth of the young trees makes such a demand upon the carbohydrates elaborated in the leaves that little or none is available for the fruit and the latter falls from the tree from "starvation." Where the growth is not so rapid, an occasional fruit may continue to develop, especially on some small branch which is not making a very active growth. The senior author has observed peaches mature and ripen on nursery trees the second summer after budding, but these trees were on dwarf roots and did not expend their all energy in vegetative growth. Trees only one or two years of age from the bud occasionally produce fruit if their growth is checked.

#### **Effect of Defoliation**

When a peach tree is partly defoliated by a caustic fungicide applied as a summer spray, the size of the fruit is below normal and the tree growth may be slow or even completely checked. The loss of foliage in such a case means a marked reduction in the amount of carbohydrates elaborated, and even though the quantity used in supporting vegetative development is small, the fruit also receives but a small amount. This also applies to trees with scanty, weak foliage resulting from other causes.

Not only is the size of each individual fruit determined by the amount of elaborated plant-food supplied to it, but its quality also is modified. When peach trees are defoliated just before the fruit becomes ripe, the fruit may reach nearly normal size, but it is insipid and lacks the sweetness of good fruit. In other words, the supply of carbohydrates from the leaves has been cut off, the fruit ripens but is lacking in this essential quality. This point also is well demonstrated by cantaloupes when the foliage has been destroyed by blight.

#### **How Early in the Season Does Rate of Growth Affect Size of Fruit?**

Observations show that peaches of the same variety may vary greatly in size on different trees soon after the fruit has set, where there is a marked difference in the rate of growth of the trees. The small green fruits on vigorous but slow-growing trees, where translocation of foods is slightly checked, exceed in size those developing on rapidly growing young trees. In other words, the fruit grower can tell early in the season whether his trees are making the proper rate



of growth to produce fruit of large size. Figure 14 illustrates green Elberta peaches picked the same day in the state experiment orchard at Vineland. The fruits in the upper portion of the picture were taken from a highly fertilized and rapidly growing tree, while those in the lower portion of the picture were taken from a tree checked



FIG. 14—GREEN ELBERTA PEACHES PICKED THE SAME DAY IN THE SAME ORCHARD. THE SMALLER SPECIMENS WERE FROM YOUNG, RAPIDLY GROWING TREES, THE LARGER ONES FROM A VIGOROUS TREE CHECKED AS BY GIRDLING

in growth by girdling. The latter will mature into larger specimens. Attention should be called to the fact that a general check to the whole tree, as the effect of a drought, for example is entirely different from a check in the processes of translocation of foods due to winter injury and other factors. The orchard at Vineland with its numerous fertilizer plots and trees of different ages offered exceptional facilities for such observations. It should be remembered that the number of the fruits on the tree and the supply of moisture are always factors in determining the size of the fruit.

**Rate of Growth as Affecting Time of Maturity**

Normal, slow growing peach trees may ripen their fruit from a few days to 19 days earlier than rapidly growing trees of the same variety in the same locality. During the season of 1914 at Vineland, Elberta began to ripen its crop August 19 on a plot receiving no nitrogen, while it did not begin to ripen on a plot receiving 10 tons of



FIG. 15—PEACH TREE WITH ONE BRANCH GIRDLED BY A LABEL WIRE.  
NOTE ROLLING OF THE LEAVES

stable manure per acre until August 27, a difference of 8 days. Some well fertilized young Elberta trees in the same orchard did not begin to ripen their fruit until September 7, a difference of 19 days between the older, slow growing trees and the younger rapidly growing ones. Slow growth, therefore, is correlated with early maturity. Slow growth, also means the early storage of reserve food in the twigs, branches and roots. We may also express it in this way: that slow but vigorous growth and early storage of reserve food promote large size and early maturity of the fruit.

**Rate of Growth as Affecting Fruit-Bud Formation**

Where slow, but vigorous growth occurs and the reserve food is stored up early, fruit-bud formation also takes place early and the buds become large and plump before winter. Such trees mature and



FIG. 16—SAME TREE AS IN FIGURE 15 SHOWING CONDITION LATER IN THE SEASON

shed their foliage earlier than rapid, late growing trees. Rate of growth thus determines the time and degree of maturity of the twigs and fruit buds as well as of the fruit. A very weak, slow growth may result of course in small, poorly developed fruit buds. Trees that mature their fruit and fruit buds early in the fall tend to start into growth more promptly in spring than rapidly and late growing trees.

**Effect of Girdling Upon the Size and Maturity of the Fruit**

We have been noting the normal fruit development of the peach under varying conditions or rates of growth and certain abnormal



factors need now be considered. The most important of these is girdling or a check to the downward translocation of elaborated plant-food from the leaves toward the roots. This results in the accumulation of food above a certain point. Girdling may be accomplished artificially by "ringing" or cutting through the bark and removing a



FIG. 17—ROLLING OF THE LEAVES UPON YOUNG PEACH TREE IN LATE SUMMER AS A RESULT OF PREVIOUS WINTER INJURY TO THE BARK OF THE MAIN ROOT JUST BELOW THE COLLAR

portion, either partly or completely around the stem, branch or trunk. A similar effect is often brought about by label wires, borers, careless cultivation or by weather injuries and stock troubles. A check to growth and sap circulation may be brought about also by scale, brown rot cankers or injurious spray mixtures that cause a hardening or partial killing of the bark at any point. The common forms of winter injury which may have the effect of artificial girdling are injury to the wood by low winter temperature and injury to the bark on the main trunk, just at or below the surface of the ground.

It has been noted that early storage of elaborated food tends to hasten maturity of fruit under normal conditions. Enforced storage of starch in any portion of a tree may then be expected still further to promote maturity or cause premature ripening of the fruit. It is a



FIG. 18—ILLUSTRATION OF SAME TREE AS IN FIGURE 17 SHOWING CONDITION A LITTLE LATER IN SEASON. NOTE NORMAL TREES IN FULL FOLIAGE IN BACKGROUND AT RIGHT

well-known fact that girdling or ringing will hasten the maturity of grapes, a practice which is sometimes followed.

Complete girdling of a peach tree near the ground as a result of winter injury commonly causes its death before the fruit has an opportunity to ripen, but if the girdling is not complete, enlargement of the fruit and early maturity is commonly the result. Such behavior by a tree has not infrequently led to the belief that it was a special strain or bud sport. Fruit from girdled trees is readily distinguished from normal fruit by the enlarged lenticels, or dots, as illustrated in figure 27. Such fruit is invariably astringent, apparently because of the increased tannin content. Girdling, either artificial or otherwise,

results in early fruit-bud formation and early falling of the foliage. A girdled branch or tree is readily recognized by the tendency of the foliage to lose its flexibility and for the leaves to roll inward from the margins toward the midribs, as illustrated in figure 17. The margins of the leaves frequently become reddish in color, and the leaves themselves may become a lighter green in color. Rather weak,



FIG. 19—A NORMAL J. H. HALE PEACH SURROUNDED BY BUTTONS  
sickly appearing shoots or suckers occasionally develop on a peach tree below the point of girdling. These symptoms are practically the same as those due to yellows.

#### Further Details of Weather Injuries

Winter injury to the wood of peach branches and twigs may bring about results identical with artificial girdling, or in other words, cause abnormal size and early maturity of the fruit. The opposite effect also may occur; that is, the fruit may remain small and cling to the tree after the normal fruit has ripened, exactly like the "buttons" specimens on the J. H. Hale shown above in figure 19. Observations seemed to indicate that the injury in such cases occurred either in the stem of the peach itself or in the twig near the point of



the attachment of the stem, which only permitted a small supply of plant-food to reach the fruit instead of an extra large quantity, as in the case of the very large fruits. Further investigations may show that this is correlated with defective pollination as suggested previously on page 18.

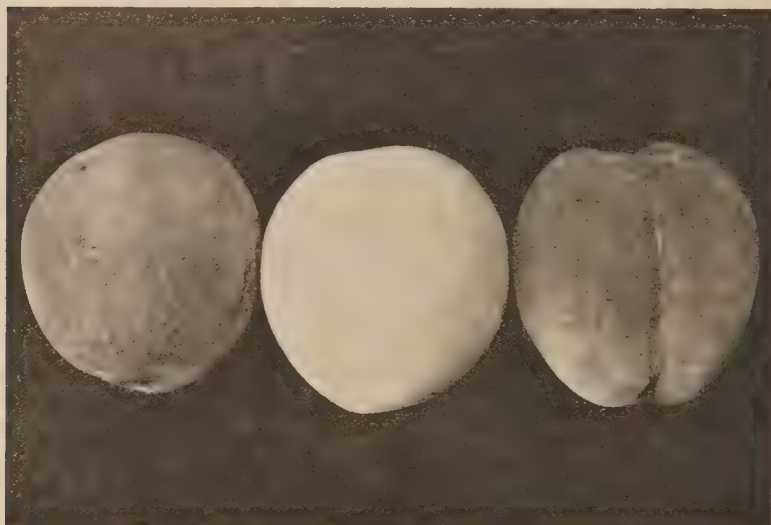


FIG. 20—TWO NORMALLY COLORED BELLE OF GEORGIA PEACHES ON EITHER SIDE OF ONE KEPT COVERED WITH A BLACK PAPER BAG

### **Factors Which Determine Color of Healthy Fruit**

The normal red coloring on peaches is the result of maturity and exposure to sunlight, with temperature as a possible factor, as illustrated in figure 20. Abnormal colorings of various sorts may appear on the fruits at various times. Where the foliage is severely burned by sprays, the red colorings may become purplish in appearance, and even where no spray burning actually occurs sulfur sprays often irritate the skin of the small green fruits so that purplish or abnormal colorings result. In seasons when winter injuries occur to the wood of the twigs and branches, so as to produce enlarged fruits, all sorts of injuries, such as limb scratches and curculio stings, may result in unusual color markings, probably because of the increased sugar content. In addition to such markings, many fruits developed blotches of red color practically identical with yellows in the Vineland orchards during the season of 1913.

## EXPLANATION OF PLATES 1 AND 2

Plate 1 is a record of the trees which became diseased each year in orchards 1 and 2. Orchard 1, set in the spring of 1907, consists of rows 1 to 27 at the left of the center road. Orchard 2, set in 1908, consists of rows 1 to 28 at the right of the center road and of rows A to F adjoining orchard 1. Those blocks of trees inclosed in squares and rectangles were Elbertas, the remainder consisted of various varieties.

Plate 2 is a record of the trees which became diseased in orchard 3, which was set in 1912. Three trees each of thirty-one different varieties were located in rows 1 to 31 at spaces 6, 7 and 8.

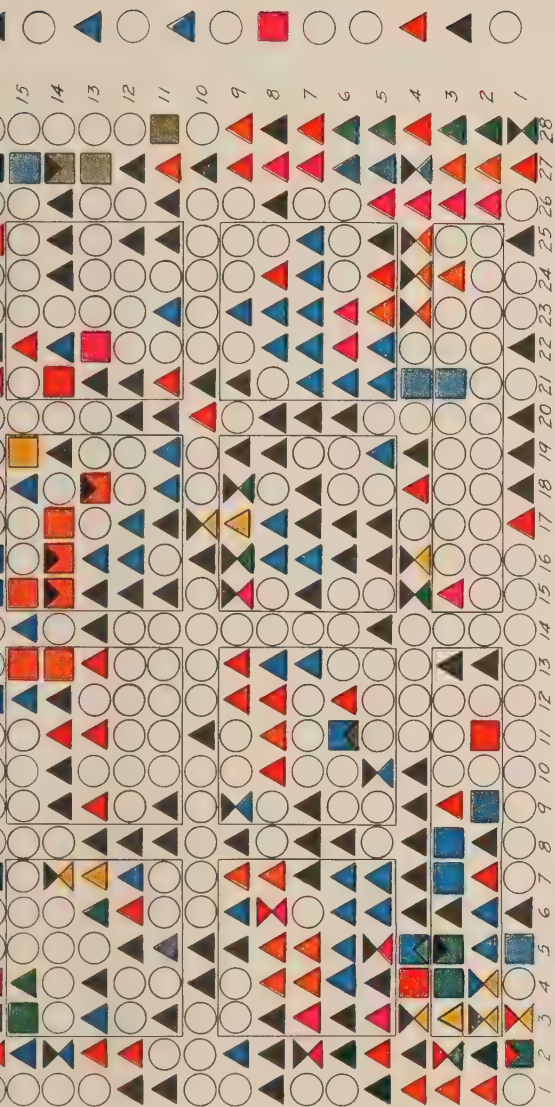
A circle represents an original tree that apparently remained healthy; a triangle, an original tree removed because of little peach; a square, an original tree removed because of yellows; a square with a large triangle, an original tree removed because of both yellows and little peach. A triangle or square of one color indicates that the replant remained healthy, while a double triangle, small triangle within a square or double rectangle indicates that the replant became diseased. Every one of the second replants or the third tree to be set in some spaces remained healthy.

The colors for the years 1909 to 1914 are light, while the colors for the years 1915 to 1920, in which the heavier losses occurred, are of darker shades.





GROVE



Original trees  
still standing

LEGEND -

△ Little Peach.  
□ Yellow.  
□ Both Yellow  
and  
Little Peach.  
⊗ Little Peach.  
⊗ Little Peach.

⊗ Yellow after  
Little Peach  
after  
Yellow.  
⊗ Yellow after  
Yellow.



⊗ Hedge - row

Plots  
of  
Elberta

1909 1912 1915 1918  
1910 1913 1916 1919  
1911 1914 1917 1920

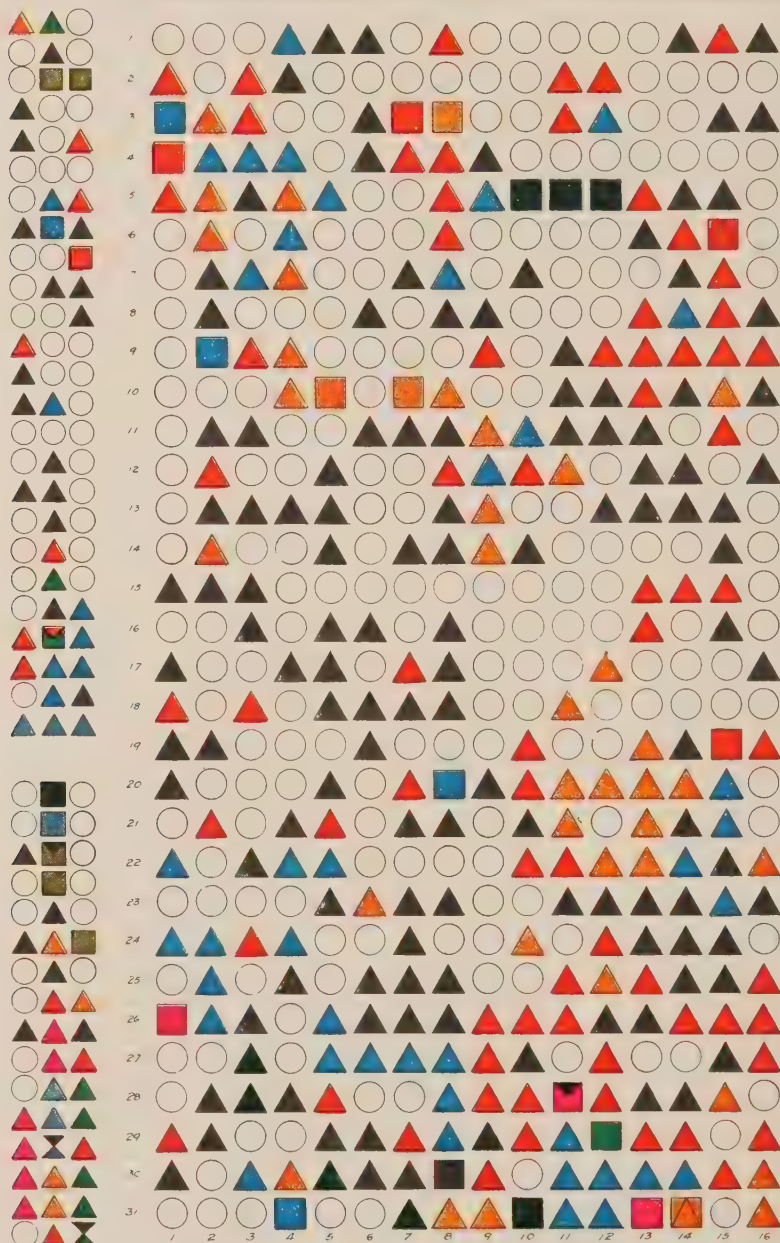


→ Site of Neglected Orchard - Removed 1909 - Every tree was DISEASED, YELLOWS.

ORCHARD NO. 1

ORCHARD NO. 2

Neatlested Orchard since 1913      Cultivated Orchard since 1913



Brushland

Brushland cleared 1916

Small Fruits

Uncultivated Headlands

### Suggestions for Differentiating Cases of Yellows and Little Peach from Other Troubles

It requires close study and observation to become expert in the identification of yellows and little peach, especially in the early or preliminary stages. Factors resulting in symptoms resembling yellows and little peach have been mentioned and some suggestions are now given to aid in tracing down and determining the cause of any suspicious symptoms.

1. The characteristic, wiry, finely branched shoots are a reliable indication of yellows on budded varieties. Unbudded seedlings may produce slender wiry looking shoots when healthy.
2. If the fruit matures much in advance of the normal season of ripening and is distinctly red-spotted and blotched, it is strong evidence of yellows. Prematuring of fruit as a result of yellows also is commonly associated with foliage symptoms.
3. In some seasons there is considerable red-spotting of fruits as a result of weather factors or spray injuries. Study these seasonal effects thoroughly before undertaking orchard inspection for the elimination of yellows.
4. Neglect and starvation will result in weak, yellow-appearing trees, but one should be able to diagnose such a condition without difficulty.
5. If the foliage of any part of a tree is abnormally light green or yellow-green in color and is curled or rolled, examine the twig or branch down to the point where it joins the normal part of the tree. Look for injuries such as brown rot cankers or girdling in any form. If no such injuries can be found, the tree becomes a suspicious case and may be diseased with yellows or little peach.
6. When the abnormal yellow and rolled appearance of the foliage of a branch or the whole tree extends to the surface of the soil, the trouble is almost certain to be located below ground unless it is a case of yellows or little peach. Remove the soil from about the trunk and main roots and look for girdling by borers, mice, winter injury or other factors. These injuries may be located as far as 10 or 12 inches below the surface. Cut into the bark upon the trunk and main roots and note whether it has a healthy normal color. If it is yellow, spongy, or brown, injury is indicated. If the injury is serious such trees are likely to show rolling and yellowing of the foliage, enlarged fruits and lenticels and prematuring. The fruit will seldom be red-spotted and blotched unless the tree is also affected with yellows. Trees seriously girdled or weakened as a result of any cause are of little value and are often best removed whether diseased or not. A tree with yellow rolled and drooping foliage in midseason without any root or bark injuries is a very suspicious case of an early stage of yellows or little peach. In late fall when growth has ceased the foliage may become somewhat rolled on healthy trees.
7. The foliage of trees in a tilled orchard suffering from drought is always wilted and flaccid and readily distinguished from the drooping but turgid condition of the leaves on trees affected with yellows or little peach.
8. Peach trees suffering as a result of poorly drained soil or certain unknown, unfavorable soil factors on some well-drained soils can be distinguished from yellows or little peach as follows:

The poorly drained areas in an orchard are readily traced in most instances. If there is any doubt after a surface survey, an examination of the subsoil will usually reveal the true conditions.



The peculiar mottling, yellowing and checked growth due to the unknown soil factor can be distinguished from yellows and little peach by the eye, after one has become familiar with it.

The difference can be determined also by a starch test of the foliage in early morning. The foliage behaves normally in that the starch is completely transferred at night while in yellows and little peach foliage there is an accumulation of starch.

9. Little peach in bearing trees can usually be distinguished from other troubles which resemble it by the combination of symptoms of the small, below-normal and late-ripening fruit and the characteristic drooping yellow green foliage.
10. The peach "buttons" described on page 18 can be readily distinguished from little peach by the fact that some normal fruits are found with the "buttons." If all the fruits should happen to be "buttons," the foliage should still appear normal, thus clearly distinguishing it from little peach.
11. In some cold, wet seasons the fruits of some varieties such as Mountain Rose and Lola remain exceptionally small and if the soil is heavy or not well drained, or if there is a lack of nitrogen, the foliage may also appear light green or yellow thus resulting in symptoms quite similar to those of little peach. One should be cautious about removing trees under such conditions.

### **Propagation of Trees from Pits from Diseased Trees**

Observation by a number of workers indicate that very few pits from diseased trees grow, and that there is likely to be little danger of the distribution of the disease in the use of pits from diseased trees. At the time this work was done, however, less prominence had been given to the fact that yellows may possibly be present in trees for a long period of time, before advanced symptoms of the disease appear. This raised the question whether pits from such trees might not germinate and carry the disease.

Pits which had been collected from trees in advanced stages of yellows and also from trees having only one branch showing marked symptoms of disease, were planted in various ways. Pits saved from from branches showing prominent symptoms of the disease, and where the fruit prematured much in advance of the normal season, were usually without embryos and of course failed to grow. However, some of the pits from trees in the early stages of yellows which contained well formed embryos, failed to germinate when placed either in the greenhouse or outdoors. Some essential factors appeared to be lacking in the seed.

In the spring of 1913, a considerable number of seedling trees were found growing under a Ray tree affected with yellows at the High Bridge orchard. This tree had been under observation from the time it was planted in 1906 and produced premature fruits in 1911 and 1912. From the fact that the tree was affected with yellows, the

fruit had been allowed to fall to the ground for two years in succession. The tree was in a corner of the orchard close to a woodland, so that the soil under the tree became covered with leaves in the fall and this probably favored the production of seedlings from both lots of pits.

Both new and one-year-old seedlings were transferred to nursery rows at New Brunswick. These seedlings made a good growth, as illustrated in figure 21, and remained in an apparently healthy condition until 1918, when they were removed to make room for other stock. No disease, therefore, developed during the five years in the nursery.



FIG. 21—HEALTHY SEEDLING TREES SECURED FROM UNDER RAY TREE AFFECTED WITH YELLOWS AT HIGH BRIDGE, NEW JERSEY

While the pits from most seriously diseased trees fail to grow, individual trees are found with only slightly affected branches from which a considerable number of pits will grow. This station has no record, however, of a single diseased tree being produced in this manner. All of our pits that have germinated have produced healthy trees.

#### **Propagation with Buds from Diseased Trees**

In an effort to determine something further in regard to the period of incubation and the appearance of distinctive symptoms of yellows,

buds from trees in various stages of the disease were used in propagation work. The appearance of diseased trees in the Experiment Station orchards which had been under close observation from the time of planting furnished sources for buds. The results of this propagation work have very clearly established the fact that the time of appearance of prominent symptoms of disease in the budded stock varies greatly according to the tree from which the buds were cut, and also according to the portion of the tree from which the buds were taken.

Early in July, 1912, a Fitzgerald tree in orchard no. 2 at Vine-land (fig. 22) suddenly developed a large number of characteristic yellow shoots. Previous to this time, the tree had not even displayed the common early symptoms of the disease, even as late as June of the same year. Buds from this tree taken for propagation in August gave very striking results the following spring. Nursery stock budded with material from this tree in August began to develop characteristic yellows shoots immediately the following spring, as illustrated in figure 23. In one instance the bark about an inserted bud became attached to the stock but the bud itself died, yet the stock began to develop characteristic yellows growths in early spring, which rapidly became more prominent as the summer advanced. Figure 24 shows the appearance of this seedling in the summer following the budding. The main crotch of the seedling was 13 inches above the point where the inserted bark was attached and one of the yellows shoots had developed at a point  $8\frac{1}{2}$  inches above the crotch by July 7, 1913, or less than a year following the inoculation. Some of the trees propagated with these diseased Fitzgerald buds did not show prominent symptoms of the disease until the latter part of the summer following budding. A few of the trees stopped growth in the late summer during a dry period and when they resumed growth after a rain the characteristic shoots appeared. This entire lot of stock was carried over until the spring of 1914, but a large percentage of the plants died. Two, however, remained alive during 1914, but made scarcely any growth.

This original Fitzgerald tree appeared to have a most virulent form of yellows and in an exceptionally short time trees budded from it developed very pronounced symptoms of yellows. Late in the same summer, August, 1913, buds were selected also from branches of an Elberta tree which developed premature fruit for the first time in



1913. This case may be described as a mild one, since prematuring occurred on the diseased branch only a few days before the normal ripening period of Elberta. The other branches on the tree matured their fruit at the normal time, and this fruit was free from the characteristic color blotches. Buds were taken from both the branches producing premature fruit and from other branches on the tree and used for propagation. Large well developed trees were secured from both lots of buds, and none of them showed any of the advanced



FIG. 22—FITZGERALD TREE AT VINELAND WHICH DEVELOPED VIRULENT CASE OF YELLOWS

symptoms of yellows during 1914. However, three of the trees propagated from buds from the diseased branch began to show the characteristic drooping and rolling of the leaves in the latter part of the season. All of the other trees of this latter group made a good growth and appeared perfectly normal. These were kept growing during the season of 1914, and none of them developed the typical sickly, wiry shoots.

The three trees exhibiting early symptoms in 1913 showed somewhat similar symptoms in 1914, and in about the same manner, but

none of the typical wiry shoots developed. In July, 1915, they appeared sickly but were still alive and had not developed any advanced symptoms. The other trees, propagated from the apparently healthy portion of the diseased tree, did not grow well, and did not show any advanced symptoms of disease until after 1917. These and other instances not reported in detail indicate that there may be a marked difference in the virility with which buds from the same tree or different trees transmit the disease.

#### **Propagation by June Buds**

Another method of determining the time rate of incubation of the disease through the process of June budding was planned. On June 10, 1913, buds were taken from a Mountain Rose and from a Ray tree at High Bridge which had been showing advanced symptoms of yellows for two years. In other words, buds were taken from trees showing unmistakable evidence of yellows for at least a year previous to the time of cutting the buds. Some of these buds were inserted in bearing Belle of Georgia trees on June 11 and others were budded upon peach stock in the nursery. The buds united well upon the Belle of Georgia trees and no apparent effect could be noted on these trees throughout the season of 1913. Even the fruit within a few inches of the inserted diseased buds ripened normally and at the same time as fruit on normal trees. Symptoms of disease began to develop about each inserted bud the following summer. One tree developed little peach in a branch where a bud from a yellows tree was inserted.

The June buds in the nursery made a good growth and no characteristic yellows shoots developed during the season of 1913. Toward the latter part of the summer, however, leaves on these June buds were somewhat rolled but whether this was actually due to the disease is open to question, as normal trees will occasionally behave in the same manner if soil conditions are dry near the end of the growing season. These trees, however, appeared to display this character to a greater degree than normal trees.

All of these June budded trees were transplanted from the nursery row in the spring of 1914, to give them more space. None of them developed characteristic yellows shoots during the season, but a few of them began to show drooping and rolling of the foliage during the latter part of the season. In the early spring of 1915, some of these trees began to make growth in advance of normal trees, and one be-

gan to develop a few wiry shoots in June. Others began to show symptoms of yellows in the leaves, while some still appeared normal. The trees gradually became less vigorous and more sickly during the next two years and were finally removed to make room for improvements.

Young trees suspected of being in the early stages of yellows and little peach have been closely watched at the New Jersey stations at different times and have almost invariably developed the advanced symptoms after three or four years. These and other observations indicate that it requires several months at the earliest for yellows to develop in a tree sufficiently for true symptoms to occur, and further, that yellows may be present in a tree for from one to four seasons before even suspicious symptoms appear. In other words, trees may appear perfectly healthy and normal for one or more years, even when actually infected with the disease.

When buds are cut from trees showing very slight symptoms of the disease, it is quite likely that nursery trees may be produced from them which will not show advanced stages of yellows for three or four seasons after planting. The writers have occasionally observed trees developing yellows very suddenly the fourth summer after planting. It seems probable that some of these trees were diseased before they left the nursery.

Still further propagation work was conducted in the fall of 1913 from several trees in the experiment station orchards. A Moore's Favorite tree developed the yellows on a very small branch in June, 1913. The remainder of the tree appeared perfectly normal, ripening its fruit in a normal manner and at the usual time. Buds were cut from the diseased portion of the tree and inserted in nursery trees and the resulting trees developed characteristic yellows shoots on the stock during the summer of 1914. Trees produced from buds from the apparently healthy branches remained normal during 1914, but gradually developed yellows until all were affected by 1918.

### **Inoculation with Juices**

In 1916 several attempts were made to inoculate healthy trees with juice from the leaves and fruits of diseased trees. Leaves and twigs from the diseased Fitzgerald nursery trees were crushed and some Triumph buds soaked in this solution for 24 hours and then budded into healthy trees. For some reason the buds failed to grow and the trees remained healthy. In another instance solutions were



prepared from leaves of yellows and little peach trees and also from premature yellows fruits and inserted into healthy trees in small test tubes. Grooves were cut in the trunks near the ground with a chisel, the tubes of solution inserted in them and the grooves sealed with grafting wax. None of the trees developed disease as a result of these inoculations.



FIG. 23—YELLOWS DEVELOPING IN THE NURSERY THE SEASON FOLLOWING BUDDING WITH DISEASED FITZGERALD BUDS

#### **Occasional Healthy Branches on Diseased Trees**

Previous investigations have shown that buds from apparently healthy branches on diseased trees invariably produce yellows when budded upon healthy stock although it may be several seasons before the symptoms appear. During 1916, when special studies on translocation of plant-foods were being made, an Early Crawford tree developed yellows in one small branch and the fruit on it matured about one week in advance of normal. The remainder of the tree ripened its fruit at the normal time and showed no abnormal colorings. Starch tests in the early morning showed an accumulation of starch in the midribs of the leaves on all branches except one which behaved normally in every way. Buds were taken from this branch and from the diseased one and transferred to healthy seedlings in the

nursery in August. Several trees were secured from each lot and planted in a chicken yard after they were one year old. All those propagated from the diseased branch became diseased within the first two years after planting but the trees propagated from the apparently healthy branch have remained healthy to date (1921). This has been the only case of this sort found at the New Jersey station. It is probable that there are instances where an entire tree may not be affected with yellows or little peach after one branch has begun to show unmistakable symptoms of the disease. It is not believed that such a condition would continue for very long.

### **Pollen not a Carrier of Disease**

During the early spring of 1916, the junior author, in conducting breeding work with peaches, planned some crosses in which a tree of the variety Dewey located on the College Farm was used as a pollen parent. Soon after the tree set fruit it developed unmistakable symptoms of yellows and was pulled out and destroyed. In the meantime the pollen had proved to be viable and a good set of fruit resulted from the crosses. The pits secured from the crosses were stratified and planted in the nursery row in the spring of 1917. A total of 45 trees were obtained and these were planted out in orchard form in the spring of 1918. They are now (May, 1921) entering upon their fourth season's growth in the orchard. Thus far they have shown no symptoms of disease.

### **Starch Tests**

During the seasons of 1913 and 1914, the horticulturist found the time available to make some special starch studies with some of the diseased and healthy trees in the Vineland orchards. C. A. Schwarze of the department of plant pathology was assigned to assist in this phase of the work. The behavior of yellows trees is so similar to that of healthy trees that have been girdled in any way or whose normal growth has been interfered with by weather, insect or disease injuries that a study of the translocation of starch in normal and diseased trees appeared to be a logical line of investigation.

### **Premature Ripening of the Fruit**

It is a well known fact that girdling causes a premature ripening of the fruit, which is also a symptom of peach yellows. Therefore, it was considered advisable to make certain comparative starch tests on leaves from mechanically girdled trees, winter-injured trees, yellows trees and little-peach trees. All these tests showed that the starch was not completely transferred at night but that much re-

mained in the midribs of the leaves at all times. The amount of starch remaining in the leaves was found to be in direct proportion to the severity of the yellows, or little peach, or the completeness of the girdling or winter injury. The leaves from trees affected with yellows showed a greater starch content in the early morning than the leaves from girdled trees with a corresponding rate of growth. The cause of the prematuring of the fruit on the yellows trees and girdled trees is apparently due to the interference with the processes of translocation of the food supply. No explanation has been obtained of the contradictory behavior of little-peach trees. In this disease, starch accumulations are found, but the fruit is delayed in ripening instead of ripening prematurely. The peaches on some branches of a yellows tree frequently premature considerably in advance of those on other branches, and if prematuring is in proportion to the severity of the check to growth, this should be indicated in starch tests. Examinations of carefully selected leaves and twigs demonstrated this point very clearly. The more advanced the disease in any one branch, the greater the starch residue found in the leaves in early morning.

The tips of branches of diseased trees commonly appear quite normal and make a more free growth than those in the center of the tree. Tests made in the early morning showed much less starch in the growing tips than in the older parts of the twigs.

#### **Studies with Healthy Trees**

If early maturity of the fruit of healthy trees depends upon a slow rate of growth and the early storage of starch in the fruit and twigs, then we would expect to find a larger amount of starch in the leaves of slow-growing trees in early morning than in those of rapidly growing trees.

As previously noted, the fertilizer experiments at Vineland included plots without nitrogen applications and plots with considerable amounts of nitrate of soda or stable manure. The plots without nitrogen matured their fruit considerably in advance of those that received nitrogen in some form, as noted previously. This is to be expected, as the latter plots were making a more active growth. Leaves of healthy trees from various plots were tested for starch in the early morning. The results of examinations indicated that the amount of starch found decreased with the vigor and rapidity of growth. In other words, the leaves from the trees in the no-nitrogen plots contained the most starch, while those from the trees receiving the



most nitrogen contained the least. The behavior of the trees agrees perfectly with the principles of plant growth previously stated.

**Development of Advanced Symptoms of Yellows Inversely Proportional to Rate and Vigor of Growth**

It has been noted that yellows appears to develop most rapidly in bearing trees and especially in neglected trees. We have noted further that yellows is similar in its behavior to the effects of slow growth, to girdling and to interference with downward translocation of foods. We can now understand why the prominent symptoms of yellows develop more rapidly in bearing, slow growing or checked trees. If the condition of the trees is such that the translocation of carbohydrates is slow, the influence of yellows will cause prematuring and other symptoms within a shorter time than would be the case in normal rapidly growing trees. Or in other words, if a tree is growing rapidly, it will require a longer period for the disease to check the growth sufficiently to produce the advanced symptoms of yellows than it will if the growth is already checked by fruiting, by injury or by neglect.

**Starch Tests with Diseased Nursery Trees**

Examinations were made late at night and in the early morning of the leaves of some of the peach trees propagated in the nursery from diseased buds to note whether the interference with the transfer of carbohydrates was as great as in bearing trees. The morning examination showed that there was less starch in the leaves of diseased nursery trees than is usually the case in diseased bearing trees. Nursery trees grow rapidly and this behavior is in keeping with the observations on diseased bearing trees, that with more rapid growth, less starch is found in the midribs of the leaves in the early morning of each day.

**Storage of Starch in Branches and Roots**

After it had been determined that differences in growth could be readily correlated with the amount of starch found in the leaves in the early morning, further tests were planned to determine the relative amounts of starch in the branches and roots.

Starch tests of the twigs, branches and roots of peach trees at Vineland (1913 and 1914) showed that the amount of starch in the branches and roots steadily increased until the falling of the leaves; and at that time the slow growing but vigorous trees, or those on the plots receiving no nitrogen, contained a much larger percentage of starch than the roots and branches of the more rapidly growing

trees on the plots that had received nitrogen or stable manure. A still smaller quantity of starch was found in the roots of the trees in the younger orchard. The starch content in the roots of vigorous yellows trees was in excess of that in the slow growing normal trees. The



FIG. 24—YELLOWS DEVELOPING ON A HEALTHY SEEDLING THE SUMMER FOLLOWING BUDDING WITH A DISEASED FITZGERALD BUD. THE LATTER FAILED TO GROW, BUT THE DISEASE WAS TRANSMITTED

early storage of starch by trees in good vigor, therefore, indicates that the total quantity of starch stored should be large. Examinations of roots of very weak trees showed that the starch content of the roots was less than in the case of vigorous rapidly growing trees. This would be expected, since the foliage on such trees would be weak and scanty and incapable of producing much starch. It was also noted that there was some variation in starch content between different roots of the same tree.

### **Storage in Leaves at the Time of Fall from Trees**

The fact that there was not a complete transfer of the starch from the leaves of diseased trees indicated that considerable quantities of starch might be lost at the time of leaf-fall. Starch tests, therefore, were made as the leaves were falling from the trees, and very large quantities of starch were found in such leaves as compared with leaves from healthy trees. This was true of leaves that were quite yellow, as well as of those that still retained some green color. This was especially true of leaves falling from yellows trees, but somewhat similar results were noted in the case of girdled trees and those which were making slow growth.

### **When Is Reserve, or Stored Starch Exhausted?**

Having observed the storage of starch in the branches and roots during the growing season, the studies were carried further in an attempt to determine when the reserve starch supply would become exhausted and whether the varying amounts as stored by trees under varying conditions of growth would result in any marked differences of growth the following spring. Tests were made at various dates, namely, April 15, May 8, May 25 and June 1, 1914. It was not until May 25 that the roots of the young trees set in 1912 became practically clear of starch. More mature but healthy trees in orchard no. 2, set in 1908, still showed a little starch in the roots, and the slow growing trees on the "no nitrogen" plots in orchard no. 1 showed a trifle more. Several yellow trees, including plot 19, tree 25, showed still more starch in the roots.

On June 1, 1914, another examination was made of the roots of the same trees and all were found to be practically free of starch except those that were diseased. At this time, the green peaches measured  $\frac{3}{4}$  to 1 inch in length. The yellows and little-peach trees which showed a very large starch content in the fall appeared to retain it late in the spring. The trees with unusually large starch content, whether diseased or girdled, made bud and leaf growth more promptly in the spring than those which contained the smaller quantities of starch. In other words, early and rapid leaf development was in proportion to starch content.

It has been noted previously that trees checked in growth and yellows trees bloom earlier and make leaf growth earlier than rapidly growing normal trees, but soon slow down and grow more slowly than normal trees. The early spurt in growth is apparently correlated



with the larger amount of foodstuffs which these trees store up and to the advanced condition of their buds. In all normal trees reserve food stored up the previous fall is apparently exhausted by the time the peaches reach about  $\frac{3}{4}$  to 1 inch in length. The time varies somewhat according to the rate of growth of the trees, requiring a longer period for the slow growing trees. In a normal season in the vicinity of Vineland the reserve food supply of normal peach trees would be assimilated by June 1 to 5. This is the period of the "June drop." Statements are rather frequently made that the bulk of the "June drop" is due to lack of pollination. Our studies indicate that peach blooms that fail to pollinate commonly fall from the twigs within 10 to 14 days after petal fall. The curculio and various other insects and diseases may cause a heavy drop of fruit in June, but in many cases the June drop is a normal thinning by the tree itself at the time when the reserve food has been wholly utilized.

It can readily be seen why young fruits forming upon slow growing trees have a large amount of food available for their support. Therefore, when the set of fruit is not in too great quantity, the young fruits on the slow growing trees soon become extra large.

Trees with yellows start growth early and appear quite green in very early spring, but later become yellow in color. Starch tests of the new foliage from yellows trees, however, showed that the transfer of starch was inhibited even at the beginning of growth in early spring, although only to a slight degree as compared with a later period.

### **Effect of Nitrogen Applications Upon Healthy and Diseased Trees**

The application of available nitrogen to peach trees during the growing season commonly promotes the development of leaves and branches, causing a freer and larger growth. This tends to delay the storage of starch and fruit-bud formation, and directly affects the time of blooming and growth the following spring.

It has been observed frequently that severe winter pruning will cause a yellows tree to appear much more healthy, perhaps almost normal in some cases. The tree may become normally green, make considerable growth and behave like a normal tree. Any stimulant which would cause the tree to make a rapid growth would tend to obscure the checked or girdled appearance caused by the yellows. The transfer of starch would take place more readily and the appearance of the tree would change accordingly.

A tree diseased with yellows, therefore, behaves in practically the same manner as a girdled or winter-injured tree, with the exception of the production of the characteristic shoots. If we consider that the interference with the transfer of plant-food varies in different parts of the tree and that plant-food tends to accumulate at some points, it is not at all strange that "suckers" or wiry shoots push out and make growth.

### Detailed Record of Peach Yellows and Little Peach Infestations at the Vineland Experiment Orchards

In the course of the fertilizer and pruning investigations with peaches at Vineland, a record was made of the behavior of each tree. Hence, a record has been obtained indicating the losses from the various plantings because of peach yellows and little peach. This record is continuous for a period of 14 years in one orchard, 13 years in the second, and 9 years in the third, and, consequently, is of great interest in studying the advance of the diseases.

Plans of these orchards, showing the character of the surroundings and indicating the year in which the tree was removed and whether because of yellows or little peach, are shown in plates 1 and 2. The orchards designated as no. 1 and no. 2 appear in plate 1 and no. 3 in plate 2. The trees that were apparently uninfected in 1920

TABLE 2

*Peach Yellows and Little Peach Loss from Orchard No. 1, Vineland  
675 Trees, Planted 1907*

Year	Little Peach	Yellows	Both	Not Determined*	Total	Per cent Lost†
1907 .....	0	0	0	0	0	0.00
1908 .....	0	0	0	0	0	0.00
1909 .....	..	..	..	2	2	0.30
1910 .....	4	..	..	..	4	0.59
1911 .....	..	5	..	..	5	0.74
1912 .....	4	1	..	..	5	0.74
1913 .....	3	8	..	..	11	1.63
1914 .....	5	1	..	..	6	0.89
1915 .....	3	1	..	..	4	0.59
1916 .....	2	8	..	..	10	1.48
1917 .....	24	..	..	..	24	3.56
1918 .....	28	3	..	..	31	4.59
1919 .....	34	2	1	..	37	5.48
1920 .....	181	..	..	..	181	26.81
Total.....	288	29	1	2	320	47.41

\*It is difficult to distinguish between the two diseases on young trees before they come into bearing.

†Based on total trees in original planting.

are indicated by circles. Diseased trees are designated in variously colored squares or triangles, single or double, indicating the year in which the tree became diseased, as described in the legend.

#### Annual Loss from Each Orchard

In order that the evidence may be presented in as clear a manner as possible, tables have been prepared showing the annual loss from yellows and little peach and the percentage of loss based on the number of trees originally planted.

Orchard no. 1 was set in the spring of 1907, and consisted of 27 rows of 25 trees each, a total of 675 trees. The principal variety was Elberta, set in square blocks of 25 trees with check rows of other varieties to separate the plots. The data regarding this orchard are given in table 2.

The diseases first appeared in the third summer, when two trees became infected before coming into bearing. The exact nature of the disease, whether yellows or little peach, was not determined, as it is difficult to distinguish between the two diseases in the early

TABLE 3  
*Peach Yellows and Little Peach Loss from Orchard No. 2, Vineland*  
550 Trees, Planted 1908

Year	Little Peach	Yellows	Total	Per cent Lost*
1908	0	0	0	0.00
1909	0	0	0	0.00
1910	1	..	1	0.18
1911	4	3	7	1.27
1912	4	5	9	1.64
1913	10	3	13	2.36
1914	14	4	18	3.27
1915	19	1	20	3.64
1916	5	1	6	1.09
1917	23	13	36	6.55
1918	55	6	61	11.09
1919	34	6	40	7.27
1920	119	1	120	21.82
Total	288	43	331	60.18

\*Based on total trees in original planting.

stages. In nearly every year there have been more cases of little peach than of yellows. Exceptions are 1911, with 5 cases of yellows and no cases of little peach; 1913, with 8 cases of yellows and 3 cases of little peach; 1916, with 8 cases of yellows and 2 cases of little peach. Since 1916 the number of infestations with little peach have



increased at a rapid rate, with relatively few cases of yellows. In 1919, one tree was infected with both diseases, each on a different part of the tree.

For the first six years in the life in the orchard the loss was relatively small, amounting to a total loss of 16 trees, or about 3 per cent of the original planting. In the seventh year (1913) there was an increase in the annual loss, when it rose to 1.63 per cent. The succeeding two years witnessed a decline, but beginning with 1916 an increased loss occurred again. From that year, with a loss of 1.48 per cent, the diseases spread and the losses increased gradually until 1919. In 1920 more trees became diseased than the total for the preceding 13 years.

The data for orchard no. 2 are given in table 3. This orchard consisted of 28 rows of 16 trees each, separated by a roadway from and located west of orchard no. 1 and of 6 rows of 17 trees each adjoining orchard no. 1 on the northeast; in the latter section the trees and rows are lettered instead of numbered. This orchard was planted in 1908, and the two sections consist of a total of 550 trees, mainly of the variety Elberta.

As in orchard no. 1, the predominating disease was little peach; in only one year (1912) were there more cases of yellows than of little peach. Likewise, the first case of the disease occurred in the

TABLE 4  
*Peach Yellows and Little Peach Loss from Orchard No. 3, Vineland*  
496 Trees, Planted 1912

Year	Little Peach	Yellows	Both	Total	Per cent Lost
1912 .....	0	0	0	0	0.00
1913 .....	0	0	0	0	0.00
1914 .....	..	1	..	1	0.20
1915 .....	..	3	..	3	0.60
1916 .....	4	4	..	8	1.61
1917 .....	35	3	1	39	7.86
1918 .....	40	4	..	44	8.87
1919 .....	70	3	1	74	14.92
1920 .....	123	1	..	124	25.00
Total.....	272	19	2	293	59.07

third year of the life of the orchard. However, in this orchard, the diseases increased gradually and at a more rapid rate than in no. 1 up to 1915. In 1916 there was a decrease in infestation, corresponding to the decrease in orchard no. 1 in the year 1915, the corre-

sponding age year. There was a large increase in 1917, another in 1918, then a slight decrease in 1919. The increase in 1920 was large, but the percentage loss was smaller than in orchard No. 1. The total loss, however, was 60.18 per cent of the original planting.

Orchard no. 3 was planted in 1912, and consists of 496 trees, arranged in 31 rows of 16 trees each. This orchard lies south of orchards, no. 1 and 2. The losses from this orchard appear in table 4.

As in the other case, the first diseased tree was observed in the third year of the life of the orchard. From then on, however, the number of trees infected increased gradually until 1916, with a large increase in 1917 (the sixth year of the life of the orchard), only a slight increase in 1918, but in the following years very large increases, 25 per cent of the original planting of trees being removed in 1920. In this orchard there were two trees (one in 1917 and one in 1919) that showed evidence of little peach on one side and yellows on the other side of the tree.

#### **Data from Vineland Orchards Show Losses from Quiet Period to Epidemic**

Peach yellows epidemics have occurred periodically in the vicinity of Vineland about once every ten or fifteen years. When the department of horticulture began experimental work at Vineland in 1907 the district had just passed through one of these epidemics, and located near the site of the experimental orchards was a small orchard about 6 years of age in which every tree was infected with yellows.

The results in tables 2, 3 and 4 show that another epidemic was under full headway in 1920. One interesting difference between the two epidemics is that the one about 1905-1907 was confined mainly to yellows, since there were only two trees affected with little peach in the locality, while in 1920 the losses were largely due to little peach. A close study of the history and behavior of these two diseases and the rosette leads us to suspect that they may be different forms of the same trouble and that climate is an important factor in causing the variations.

Figure 25 clearly shows the losses in the Vineland experimental orchards from the quiet period following the epidemic of about 1905-1907 to that of 1920. It is believed that this depicts correctly what occurs in districts where periodical epidemics of yellows occur. The

graph shows that the annual losses remained below 3 per cent from 1907 to 1913, a period of 6 years, and below 5 per cent until 1917, a period of 10 years. In the period of three years from 1917 to 1920 the losses jumped from an average of about 6 per cent to over 20 per cent.

#### Losses Small for Four or Five Years

It is quite noticeable that the losses in general are quite small until the orchards are at least four or five years of age, but during epidemics the more recently planted orchards appear as likely to suffer as the older ones.

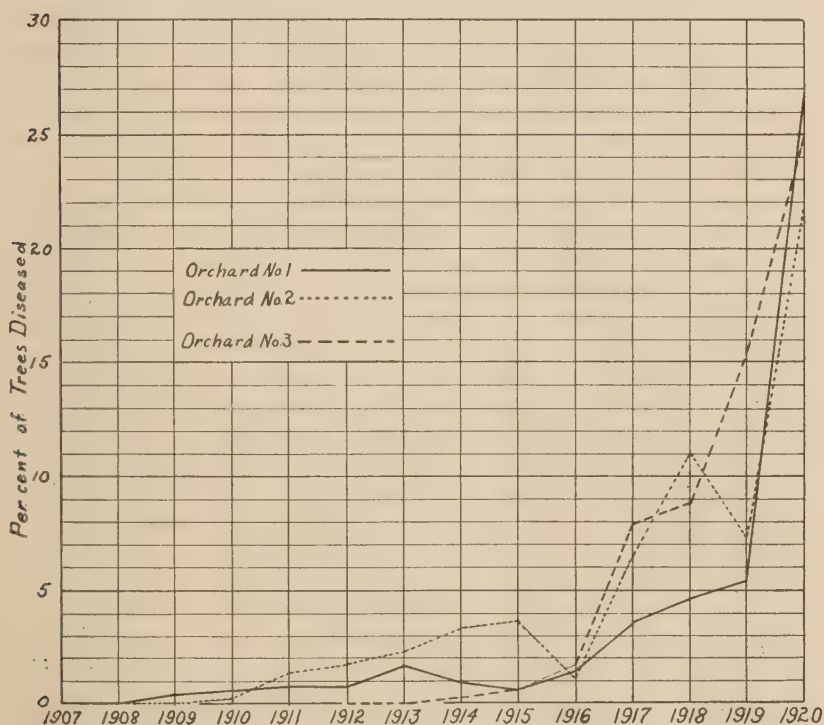


FIG. 25—GRAPHIC ILLUSTRATION OF LOSSES FROM YELLOWS AND LITTLE PEACH IN VINELAND ORCHARDS FROM 1907 TO 1920

It may be noted that orchard no. 3, set in 1912, suffered even more severely after 1916 than no. 1, which was set in 1907.



### **Susceptibility of Varieties**

A total of 75 varieties of peaches were grown in the experimental orchards at Vineland from 1907 to 1920. Only a few trees were grown of a considerable number of these varieties, so that a fair comparison cannot be drawn, but where considerable numbers were grown there appeared to be but little varietal difference in susceptibility to these diseases. It may be noted that very few of the Greensboro trees became diseased before 1920 and the same holds true with Waddell, Mayflower and Early Wheeler. These are all white-fleshed varieties of the so-called Chinese Cling group. Of Carman, in orchard no. 1 there were planted 22 trees and only 9 have become diseased so far, the majority of these in 1920, which is a particularly good record; but 120 trees of the same variety were planted in no. 3, of which 72, or 60 per cent, have succumbed.

The writers, therefore, have been unable to observe up to the present time that variety exerts any influence upon resistance to these diseases.

### **Replants Not More Susceptible Than Other Trees**

Complaints are sometimes made that trees set after the removal of diseased trees fail to grow satisfactorily. Attention should be called to the fact that all replants in orchards more than two or three years of age are at a distinct disadvantage, especially where the distance between trees is less than 20 feet each way. Replants are often set carelessly and not infrequently late in the season and receive but little attention and care. They are also handicapped because they are surrounded by larger trees which are able to usurp a large share of the available light, moisture and plant-food. Therefore, these replants start slowly and appear unhealthy because of unfavorable conditions for growth. Undoubtedly many such trees have been regarded as diseased when they were healthy.

Table 5 is compiled and arranged to show the losses due to disease among the replants at Vineland in comparison with the original trees set. The data are arranged so that the results may be noted at the close of the years 1918, 1919 and 1920. The year 1918 gives us a comparison between original trees and replants at the beginning of an epidemic and in 1920 when it was at its height.

The total average loss from disease in the original plantings in 1918 was 7.9 per cent, while the total average loss for all the replants was 3 per cent. If the comparisons are made on the basis of 1919

instead of 1918 the loss is 8.8 per cent compared with 3.4 per cent in the replants. In 1920 the original trees show a 24.7 per cent infection compared with 10.9 per cent in the replants.

On the basis of these general comparisons there is nothing to indicate that the replanting of trees following diseased trees favors infection. The claim may be made that this general comparison is not wholly fair since trees do not generally show disease for the first three or four years, which would favor the replants. Table 5 is thus arranged to show the losses in original trees and replants at the same age. For example, the losses in orchard no. 1 in the seventh season were 8.9 per cent, while 12 replants in their seventh

TABLE 5

*Loss of Replants of Various Ages Compared with Loss from Original Plantings*

Original Trees	Season of Life of Trees	1918			1919			1920		
		Total Original Planting	Number Lost	Per cent Lost	Total Original Planting	Number Lost	Per cent Lost	Total Original Planting	Number Lost	Per cent Lost
Orchard 3	7th	496	44	8.9	....	....	....	....	....	....
	8th	....	....	....	496	74	14.9	....	....	....
	9th	....	....	....	....	....	....	496	124	25.0
Orchard 2	11th	550	61	11.1	....	....	....	....	....	....
	12th	....	....	....	550	40	7.3	....	....	....
	13th	....	....	....	....	....	....	550	120	20.9
Orchard 1	12th	675	31	4.6	....	....	....	....	....	....
	13th	....	....	....	675	37	5.5	....	....	....
	14th	....	....	....	....	....	....	675	181	26.8
Total—all ages		1721	136	7.9	1721	151	8.8	1721	425	24.7
Replants	2nd	24	0	0	99	0	0	136	5	3.7
	3rd	27	0	0	24	2	8.3	99	9	9.1
	4th	25	2	8.0	27	1	3.7	24	1	4.2
	5th	24	2	8.3	25	3	12.0	27	5	18.5
	6th	14	0	0	24	2	8.3	25	6	24.0
	7th	12	0	0	14	0	0	24	8	33.3
	8th	5	0	0	12	0	0	14	1	7.1
	9th	2	0	0	5	0	0	12	4	33.3
	10th	....	....	....	2	0	0	5	1	20.0
	11th	....	....	....	....	....	....	2	0	0
Total—all ages		133	4	3.0	232	8	3.4	368	40	10.9

season of growth show no loss. The loss the eighth season in the same orchard was 14.9 per cent, while 12 replants still remained healthy. In the ninth season the epidemic caused a loss of 25 per cent of the original trees in no. 1 and a third of the replants. It is of interest to note further that the two replants set in 1910 are

still healthy in the eleventh season. All the evidence at Vineland indicates that trees replanted in the place of diseased trees are no more likely to contract the disease than any others in the orchard.

#### **Trees of All Ages Become Affected During an Epidemic**

During periods between so-called epidemics of yellows and little peach very few trees become affected with these diseases until they are at least in their fourth or fifth season's growth, unless they were diseased when planted. In orchard no. 1 the loss was less than 1 per cent until the sixth year; in no. 2, until the fourth year, and in no. 3, until the fifth year. Table 5, however, clearly shows what happens at the height of an epidemic. The losses in the replants in 1920 range from 3.7 per cent among 2-year-old trees to 33.3 per cent among 7-year trees and older. The older trees suffer the most, but toll is taken from trees of all ages.



FIG. 26—REPLANTED TREE IN NORTHWEST CORNER OF ORCHARD NO. 2 THAT MADE A GOOD GROWTH

#### **Course of Spread of Yellows and Little Peach a Puzzle**

All manner of theories are advanced from time to time as to factors affecting the spread of these diseases. This is not to be wondered at, since the diseases are so inconsistent and variable in behavior. Evidence is discovered which appears to establish some fact or principle, but later equally strong evidence is found which tends to prove the opposite.



Several such contradictory observations have already been mentioned in this bulletin, as, for example, the fact that Carman appeared to be less susceptible to disease than most other varieties in orchard no. 1, but was quite susceptible in no. 2.

#### **Does Disease Spread from Local Centers?**

It has been the general observation that where diseased trees are left growing in an orchard they become centers of infection and that surrounding trees gradually become affected. Whether this is actually due to direct infection in some manner or to environmental conditions favoring the disease in that area appears to be an open question.

A peach orchard completely infested with yellows during the epidemic of 1905-1907 adjoined the Vineland orchards at the northwest corner from 1907-1909, after which it was removed. The spread of disease in that corner of the experiment orchard has been serious. Figure 26 illustrates replants growing in one portion of this area.

An equally serious center of spread occurred at the southwest corner of the same orchard, which was bordered by a narrow hedge-row of native trees. One may also note by the colored diagrams healthy trees surrounded by areas from which diseased trees have been removed; and so the contradictory comparisons may be multiplied.

There is no definite evidence in these orchards that these diseases spread from tree to tree; yet, on the other hand, there is no strong evidence to the contrary.

Two negative facts in regard to their spread appear to be established: (1) they are not distributed by the pollen of diseased trees, and (2) the evidence is strong against their spread by means of the soil.

Some have suggested pruning tools as a possible agency of infection, but this also appears to be a factor to be placed in the very doubtful class.

### **Suggestions for Keeping the Losses by Yellows and Little Peach to a Minimum**

1. Select well drained soils and favorable orchard sites.
2. Avoid low and wet areas.
3. Purchase vigorous, clean, well grown trees.
4. Avoid weak, sickly looking trees at any price.
5. Give the orchard good culture and care every year.
6. Note the behavior of each tree in the orchard several times during a season, particularly in late May and early June, and at the ripening time for each variety. The first examination will likely reveal a number of suspicious trees. Their fate should be decided at the time the fruit ripens.
7. Mark diseased trees in an unmistakable manner, as by blazing with a hatchet. Remove diseased trees as soon as identified, if possible. At least cut the tops off close to the trunk. The trunk should be removed later, otherwise it will begin to put forth new shoots and remain a possible source of infection. The removal of prominently diseased limbs will not arrest the spread of infection on a tree.
8. Do not allow a diseased tree to remain in the orchard from summer until the following spring.
9. Do not waste time upon a suspicious individual. If it is weak and sickly in appearance it should be removed. It is better to destroy a few healthy trees that are practically worthless from other causes than to leave a few that are diseased.
10. Destroy all old peach trees that are of no commercial value. They may become sources of infection.

### Summary

Peach yellows and little peach are peculiar diseases of the peach that are responsible for heavy losses in eastern peach districts.

Yellows appeared in the vicinity of Philadelphia as early as 1791.

Little peach was not definitely recognized until 1898.

### Losses

In districts where yellows and little peach prevail 1 per cent of the trees are likely to develop unmistakable symptoms annually in the so-called quiet periods and 3 per cent is common, while during outbreaks the number is likely to reach as much as 5 to 25 per cent.

The United States Census for 1910 reports 15,503,921 bearing and non-bearing peach trees for the states of New York, New Jersey, Pennsylvania, Delaware and Maryland. A 3 per cent loss for this territory would amount to 450,000 trees.

Periodical outbreaks of yellows have occurred in eastern peach districts about once in 10 to 15 years, and several times have reduced the industry to a low point.

### Symptoms of Advanced Stages of Yellows

The outstanding symptoms of advanced stages of yellows are: (1) premature ripening and red spotting and blotching of the fruit; (2) development of characteristic sickly, wiry shoots upon the twigs and branches. Both symptoms may appear at about the same time, or one in advance of the other.

### Early Preliminary Symptoms of Yellows

Yellows and little peach can often be recognized in the early or preliminary stages.

The most reliable symptoms are a characteristic drooping of the leaves toward the branches with a slight curling downward of the tips toward the petioles and sometimes a rolling inward of the margins. Such leaves are commonly of a lighter and more yellowish green than normal leaves.

Sometimes the presence of these diseases is first indicated by a rolling of the leaves from the margins inward toward the midrib. Such symptoms may be caused by other factors, however, and a careful examination should be made of each case before making a decision.

Vigorous trees affected by either yellows or little peach are inclined to push into growth earlier and bloom in advance of normal trees and then quickly slow down in growth.

### Advanced Symptoms of Little Peach

The outstanding feature distinguishing little peach from yellows is the abnormally small fruits that are late in ripening instead of prematuring.



FIG. 27—ENLARGED LENTICELS OR DOTS ON FRUIT FROM TREES CHECKED AS BY GIRDLING

### Factors Producing Symptoms Similar to Yellows and Little Peach

Practically all of the symptoms of yellows and little peach may be brought about by other factors such as borers, winter injuries, label wires, mechanical injuries, unfavorable soils, improper fertilization and lack of cultivation. Careful and thorough examination of each case is necessary to avoid incorrect diagnosis.

### Trees More Susceptible to Disease on Some Sites Than on Others

It has been observed that peach trees of the same variety from the same nursery may be practically free from yellows when planted on



one site and become seriously diseased within 4 to 5 years when planted on another with the two sites not more than one-fourth mile apart.

#### **Propagation of Trees from Pits from Diseased Trees**

Pits from fruits which premature much in advance of the normal fail to germinate. The greater proportion of well-formed embryos from pits from trees with only one branch affected fail to germinate.

Pits from branches only slightly affected may grow. However, all such trees produced at this station have proven to be healthy.

#### **Propagation with Buds from Diseased Trees**

It has long been known that buds from trees diseased with yellows invariably reproduce the disease when budded into healthy stock.

Comparatively little was known, however, about the time required for the disease to incubate or develop in a tree.

Some buds from a Fitzgerald tree at Vineland affected with yellows in 1912 budded into healthy nursery trees in August resulted in advanced cases of yellows the following spring.

One Fitzgerald bud failed to grow, but the bark united with the healthy seedling tree and it developed advanced symptoms of yellows the following summer as illustrated in figure 24.

Buds from other trees affected with yellows did not cause advanced symptoms of the disease to develop on healthy stock for several years. Observations indicate that different buds from the same diseased tree and from different trees vary greatly as to the virulence with which they transmit the disease.

#### **June Budding**

Diseased buds inserted into bearing branches of Belle of Georgia trees in June had no apparent effect upon the trees that year. Fruits only a few inches from the inserted diseased buds showed no inclination to premature. These trees all developed disease around the inserted buds the next season. One tree developed little peach in a branch where a yellows bud was inserted.

#### **An Occasional Healthy Branch May Occur on Diseased Trees**

Buds taken from the apparently healthy parts of a diseased tree almost invariably transmit the disease. Occasionally, however, a tree is found on which a healthy branch occurs even after the prominent symptoms of disease have appeared in other portions of the tree.

June buds placed in healthy nursery seedlings grew well the first summer and failed to develop any certain symptoms of disease, but there was some rolling of leaves late in the season. These trees gradually decreased in vigor and appeared more sickly during the next two years when they were removed.

Observations indicate that it requires several months for symptoms of yellows to develop following inoculation. The shortest period in New Jersey experiments was from August of one year to May of the next. The disease may be present in a tree for at least 4 seasons before advanced symptoms appear.

#### **Breeding Experiments**

Pollen from a Dewey tree affected with yellows was used in crossing healthy trees in 1916. A total of 45 trees were secured and planted in orchard form in 1918. At the present time (1921) the trees are all healthy. It seems safe to conclude that the pollen of diseased trees does not transmit yellows.

#### **Factors Which Determine Size and Time of Maturity of Fruit on Normal Trees**

A tree must be able to maintain a certain amount of growth and vigor in order to produce fruit normally. A favorable temperature, ample moisture and plant-food are essential to this end. Given favorable conditions for growth, tree development depends upon the taking up of crude plant-food by the roots, photosynthesis by the leaves and translocation of the elaborated foods.

When a tree is young the elaborated food is used entirely for growth, but when fruit bearing begins it is used for both vegetative and fruiting processes.

Rapidly growing peach trees quite frequently set a few fruits as early as the beginning of the second or third season, but these fall off in June because the elaborated food is used for growth.

When peach trees are defoliated just before the fruit ripens it may reach good size but is insipid and lacks flavor. In other words, the starch and sugar forming processes of the tree have been greatly reduced or removed.

The rate of growth of a peach tree may begin to affect the size of the fruits early in the season. Peaches on very rapidly growing trees are commonly smaller than those on vigorous trees that are checked in any manner that acts as a slight girdling.

### **Rate of Growth Affects Time of Maturity of Fruits**

It is a well known principle that slow growing or checked trees tend to ripen their fruit earlier than rapidly growing trees.

In 1914 at the Vineland orchards mature Elberta peach trees receiving no nitrogen began to ripen their fruits 8 days earlier than trees receiving 10 tons of stable manure, while young and well fertilized Elberta trees in the same orchard did not begin to ripen until 19 days after the no-nitrogen block.

Vigorous but slow growth and early storage of reserve food tends to promote early maturity and large size of the fruit.

### **Rate of Growth as Affecting Fruit Bud Formation**

Slow but vigorous growth results in the early storage of reserve food, the early differentiation of fruit buds and the early shedding of foliage or maturity of the buds. Such buds are commonly larger and more advanced in their development than buds on trees that grow more rapidly and later in the season. Buds that are advanced in development when they enter the dormant period are the most easily started into growth during warm periods in winter. Such a condition of the buds is therefore objectionable in peach sections where more or less "open" winters are likely to prevail.

### **Rate of Growth May Affect Size of Fruit from Almost the Beginning of the Season**

Peaches on adjoining trees of the same variety may vary considerably in size soon after the fruit has set where there is a marked difference in the rate of growth and a slight check to translocation of plant-foods.

The fruits on rapid-growing young trees tend to be the smaller.

### **Effect of Girdling Upon the Size and Maturity of the Fruit**

Slight girdling of the trunk either above or just below the surface of the soil tends to cause earlier ripening, and increased size of the fruit with enlarged lenticels or dots. Such fruits are likely to be bitter and also astringent because of their increased tannin content. Severe girdling causes prematuring of the fruit and the death of the tree.

Girdled trees may develop symptoms almost identical with yellows.

### **Peach "Buttons"**

A certain proportion of the peaches on any variety may cling to the tree but remain small and undeveloped following a cold period in late winter and early spring. This is apparently due to injury to the stem of the bud or fruit or to the twig at the point of attachment of the fruit, to defective pollination, or both.

The J. H. Hale variety frequently produces such specimens but whether because of weather injuries or incomplete floral development is yet to be determined.

Such cases should not be confused with "little peach" however.

### **Factors Which Determine Color of Healthy Fruit**

The red coloring on peaches of the same variety is due to maturity and exposure to sunlight, with temperature a possible factor.

Abnormal purplish-red colorings often occur as a result of spray burning, leaf curl and other injuries.

Following winter injury peaches may develop a red spotting and blotching practically identical with yellows.





